

WHAT IS CLAIMED IS:

- 1           1.     A storage area network, comprising:
  - 2               a storage system for providing storage of system data;
  - 3               at least one application host running an application thereon and accessing data on
  - 4               the storage system;
  - 5               at least one I/O performance gateway, disposed between the at least one
  - 6               application host and the storage subsystem, for intercepting I/O operations;
  - 7               a database for storing service level agreements; and
  - 8               a Service Level Agreement (SLA) server for controlling the at least one I/O
  - 9               performance gateways based on the service level agreements, wherein the at least one I/O
  - 10              performance gateway sending statistic data to the SLA server and taking requests from
  - 11              the SLA server to control I/O operations;
- 12           wherein the SLA server further comprises:
  - 13               a database manager for maintaining connections to the database wherein
  - 14               service level agreements and performance data are maintained;
  - 15               an SLA services module for analyzing data and controlling actions based
  - 16               on the service level agreements and policy;
  - 17               an application server for communicating with clients to display monitoring
  - 18               information and for communication with the database manager; and
  - 19               a performance monitor for communicating with the at least one I/O
  - 20               performance gateway to collect data and send throttling requests based upon signals from
  - 21               the SLA services module, wherein the performance monitor is configured to provide at

22 least one thread pair for processing inbound signals from the at least one I/O performance  
23 gateway being sent to the SLA services module via an inbound thread and for processing  
24 outbound signals to the at least one I/O performance gateway received from the SLA  
25 services module via an outbound thread, the inbound thread and the outbound thread  
26 operating asynchronously to provide non-blocking messaging.

1           2.       The storage area network of claim 1 wherein the SLA services module  
2 further comprises:

3           a performance analyzer for setting throttling parameters and discovering new i/o  
4 performance gateways;

5           an entity service module for providing in-memory caching of collected statistical  
6 data by polling data from the i/o performance gateways; and

7           a policy manager for ensuring actions meet service level agreements and policy  
8 rules.

1           3.       The storage area network of claim 1 further comprising a storage resource  
2 manager for monitoring the storage system.

1           4.       The storage area network of claim 1 wherein the SLA server further  
2 includes a mailbox disposed between the SLA services module, the database manager,  
3 the application server and the performance monitor, the mailbox providing a non-  
4 blocking two-step communication scheme for allowing concurrent servicing of multiple  
5 I/O requests and database requests.

1           5.       The storage area network of claim 1 wherein the performance monitor  
2 includes a plurality of processors for controlling communication, the at least one thread  
3 pair comprising a thread pair for each of the plurality of processors.

1           6.       The storage area network of claim 5 wherein a thread pair for each of the  
2 plurality of processors are associated with a subgroup of SLA processes of the SLA  
3 services module and a subgroup of gateways.

1           7.       The storage area network of claim 1 wherein the performance monitor  
2 includes a single processor for controlling communication, the inbound thread receiving  
3 signals from all gateways and providing a path to all processes of the SLA services  
4 module communicating with the performance monitor.

1           8.     A Service Level Agreement (SLA) server, comprising:  
2           a database manager for maintaining connections to the database wherein service  
3     level agreements and performance data are maintained;  
4           an SLA services module for analyzing data and controlling actions based on the  
5     service level agreements and policy;  
6           an application server for communicating with clients to display monitoring  
7     information and for communication with the database manager; and  
8           a performance monitor for communicating with the at least one I/O performance  
9     gateway to collect data and send throttling requests based upon signals from the SLA  
10    services module, wherein the performance monitor is configured to provide at least one  
11    thread pair for processing inbound signals from the at least one I/O performance gateway  
12    being sent to the SLA services module via an inbound thread and for processing  
13    outbound signals to the at least one I/O performance gateway received from the SLA  
14    services module via an outbound thread, the inbound thread and the outbound thread  
15    operating asynchronously to provide non-blocking messaging.

1           9.     The SLA server of claim 8 wherein the SLA services module further  
2 comprises:  
3           a performance analyzer for setting throttling parameters and discovering new i/o  
4 performance gateways;  
5           an entity service module for providing in-memory caching of collected statistical  
6 data by polling data from the i/o performance gateways; and  
7           a policy manager for ensuring actions meet service level agreements and policy  
8 rules.

1           10.    The SLA server of claim 8 wherein the SLA server further includes a  
2 mailbox disposed between the SLA services, the database manager, the application server  
3 and the performance monitor, the mailbox providing a non-blocking two-step  
4 communication scheme for allowing concurrent servicing of multiple I/O requests and  
5 database requests.

1           11.    The SLA server of claim 8 wherein the performance monitor includes a  
2 plurality of processors for controlling communication, the at least one thread pair  
3 comprising a thread pair for each of the plurality of processors.

1           12.    The SLA server of claim 11 wherein a thread pair for each of the plurality  
2 of processors is associated with a subgroup of SLA processes of the SLA service module  
3 and a subgroup of gateways.

1           13.     The SLA server of claim 8 wherein the performance monitor includes a  
2     single processor for controlling communication, the inbound thread receiving signals  
3     from all gateways and providing a path to all processes of the SLA services module  
4     communicating with the performance monitor.

1           14.     A performance monitor for controlling communication between two  
2     functional entities, comprising:  
3             at least one processor configured for processing signals between at least one I/O  
4     performance gateway and SLA services module processes; and  
5             a thread pair associated with each of the at least one processors, each thread pair  
6     processing inbound signals from the at least one I/O performance gateway being sent to  
7     the SLA services module via an inbound thread and for processing outbound signals to  
8     the at least one I/O performance gateway received from the SLA services module via an  
9     outbound thread, the inbound thread and the outbound thread operating asynchronously  
10    to provide non-blocking messaging.

1           15.     The performance monitor of claim 14 wherein the at least one processor  
2     comprises a plurality of processors for controlling communication.

1           16.     The performance monitor of claim 15 wherein each thread pair associated  
2     with a processor is associated with a subgroup of SLA processes of the SLA services  
3     module and a subgroup of gateways.

1           17.     The performance monitor of claim 14 wherein the at least one processor  
2 comprises a single processor, the inbound thread receiving signals from all gateways and  
3 providing a path to all processes of the SLA services module communicating with the  
4 performance monitor.

1           18.     A program storage device readable by a computer, the medium tangibly  
2 embodying one or more programs of instructions executable by the computer to perform  
3 a method for providing non-blocking, minimum threaded two-way messaging, the  
4 method comprising:  
5           providing at least one processor for controlling communication between SLA  
6 processes of the SLA services module and at least one I/O performance gateway; and  
7           providing a thread pair associated with each of the at least one processors for  
8 processing inbound signals from the at least one I/O performance gateway being sent to  
9 the SLA services module via an inbound thread and for processing outbound signals to  
10 the at least one I/O performance gateway received from the SLA services module via an  
11 outbound thread, wherein the inbound thread and the outbound thread operate  
12 asynchronously to provide non-blocking messaging.

1           19.     The program storage device of claim 18 wherein the providing a thread  
2 pair associated with each of the at least one processors further comprises associating each  
3 thread pair associated with a processor with a subgroup of SLA processes of the SLA  
4 services module and a subgroup of gateways.

1           20.     The program storage device of claim 18 wherein the providing at least one  
2     processor further comprises providing a single processor, and wherein the providing a  
3     thread pair associated with each of the at least one processors further comprises providing  
4     a signal thread pair, wherein an inbound thread receives signals from all gateways and  
5     provides a path to all processes of the SLA services module.

1           21.     A method for providing non-blocking, minimum threaded two-way  
2     messaging, comprising:  
3           providing at least one processor for controlling communication between SLA  
4     processes of the SLA services module and at least one I/O performance gateway; and  
5           providing a thread pair associated with each of the at least one processors for  
6     processing inbound signals from the at least one I/O performance gateway being sent to  
7     the SLA services module via an inbound thread and for processing outbound signals to  
8     the at least one I/O performance gateway received from the SLA services module via an  
9     outbound thread, wherein the inbound thread and the outbound thread operate  
10    asynchronously to provide non-blocking messaging.



1           22.    A storage area network, comprising:  
2           storage means for providing storage of system data;  
3           at least one application means for running an application thereon and for  
4   accessing data on the storage means;  
5           at least one gateway means, disposed between the at least one application host and  
6   the storage subsystem, for intercepting I/O operations;  
7           means for storing service level agreements; and  
8           means for controlling the at least one I/O performance gateways based on service  
9   level agreements, wherein the at least one gateway means sends statistic data to the  
10   means for controlling and takes requests from the means for controlling to control I/O  
11   operations;  
12          wherein the means for controlling further comprises:  
13                  means for managing and maintaining connections to the means for storing  
14   service level agreements;  
15                  means for analyzing data and controlling actions based on the service level  
16   agreements and policy;  
17                  means for communicating with clients to display monitoring information  
18   and for communication with the means for managing and maintaining connections to the  
19   means for storing service level agreements; and  
20                  means for communicating with the at least one gateway means to collect  
21   data and send throttling requests based upon signals from the means for analyzing data  
22   and controlling actions, wherein the means for communicating is configured to provide at

23 least one thread means for processing inbound signals from the at least one gateway  
24 means being sent to the means for analyzing data and controlling actions via an inbound  
25 means and for processing outbound signals to the at least one gateway means received  
26 from the means for analyzing data and controlling actions via an outbound means, the  
27 inbound means and the outbound means operating asynchronously to provide non-  
28 blocking messaging.

1           23.     A Service Level Agreement (SLA) server, comprising:  
2           means for managing and maintaining connections to the means for storing service  
3 level agreements;  
4           means for analyzing data and controlling actions based on the service level  
5 agreements and policy;  
6           means for communicating with clients to display monitoring information and for  
7 communication with the means for managing and maintaining connections to the means  
8 for storing service level agreements; and  
9           means for communicating with the at least one gateway means to collect data and  
10 send throttling requests based upon signals from the means for analyzing data and  
11 controlling actions, wherein the means for communicating is configured to provide at  
12 least one thread means for processing inbound signals from the at least one gateway  
13 means being sent to the means for analyzing data and controlling actions via an inbound  
14 means and for processing outbound signals to the at least one gateway means received  
15 from the means for analyzing data and controlling actions via an outbound means, the  
16 inbound means and the outbound means operating asynchronously to provide non-  
17 blocking messaging.

1           24.     A performance monitor for controlling communication between two  
2 functional entities, comprising:  
3           at least one processing means configured for processing signals between at least  
4 one I/O performance gateway means and SLA services means; and  
5           a thread means associated with each of the at least one processors, each thread  
6 means processing inbound signals from the at least one I/O performance gateway being  
7 sent to the SLA services module via an inbound means and for processing outbound  
8 signals to the at least one I/O performance gateway received from the SLA services  
9 module via an outbound means, the inbound means and the outbound means operating  
10 asynchronously to provide non-blocking messaging.